

During the season of 1910-11 the Montana State Board of Horticulture, with the aid of a fund of considerable size raised by voluntary subscription in Ravalli and Missoula counties, has made a very determined and systematic fight against the disease in the Bitter Root Valley. The results may be determined this coming summer. That it has been anywhere near stamped out by a single year's efforts is a miracle quite beyond expectation. Indeed, if it be so checked as to do only the same amount of damage as last season, the money expended will be many times repaid; for in such locality, where susceptible varieties have been freely planted, each season's destruction will far exceed the preceding if the disease is allowed to run its own course. It should be remembered that a single good bearing orchard of Alexanders in the Bitter Root Valley will, **if the attack be delayed for a single year**, give returns equal to the whole fund expended, even though the trees be totally destroyed the next season.

In the Yellowstone Valley the blight was not reported to the Experiment Station until it had gained very great headway. The first intimation of its presence came as a verbal statement from the Billings inspector to the writer to the effect that a disease new to him had laid severe hold upon an orchard near Laurel. A trip to that place, made the same day, showed that the orchard was badly blighted. Among 1200 large Alexander apple trees and 200 Transcendent crabs, scarcely a healthy tree could be found, and in some instances there were more than a hundred separate infections in one tree. Surrounding orchards had only a few cases each. It was clearly beyond the power, and not within the duties, of the Experiment Station to check such an attack, especially at that season of the year, but it was immediately reported to the proper authorities, viz: the State Board of Horticulture. The following spring the owner top-worked the trees to more resistant varieties and, had not the blight already reached the trunks in many cases, most of the orchard might have been saved. Meanwhile the disease has spread into other orchards and joined more distant areas of infection. Great efforts are now being made to check the blight in that section.

At Miles City the disease seems to have appeared about 1905 or 1906, but was not reported until late in the summer of 1908. Then

a request came from the secretary of the State Board of Horticulture to investigate the situation there, where the conditions were said to be serious. The apple industry there is only in its infancy, but almost everywhere that apple or pear trees were found, more or less blight was also found. Two or three commercial orchards visited were diseased beyond redemption. What should have been the best one looked, at the distance of a mile, as brown as if it were autumn. In short, the conditions in certain parts of the Yellowstone Valley were so serious when first reported as to be quite beyond the reach of the Experiment Station or of the State Board of Horticulture in their straitened financial circumstances. Fortunately not many of these orchards are of the varieties most susceptible to blight, and the more resistant ones are standing it well.

At Plains the disease was reported for the first time in 1909, though it had existed in one orchard for a year or two before. The writer, with an assistant, Mr. H. E. Morris, of this station, made a most determined effort during the winter of 1909-10 to completely stamp it out, but was unsuccessful. One block of Alexanders, nine years old, was gone over with the greatest care, tree by tree, three times during the Christmas holidays, and every case that could be found was cut out. A few weeks before blossoming time (about May 1st), the inspection was repeated, every tree being closely examined four times more. During this examination many more cases were discovered and cut out, and the search was continued until no more could be found. Nevertheless, some were overlooked, being practically invisible, and these started a severe infection at blossoming time, which ruined the orchard before the season was finished.

This experience taught a most important lesson,—that while in the pear practically every case of blight can be found and cut out during the winter, such is not the case with the Alexander apple. The bark of this variety is so dark and the blighted areas are often so nearly normal in appearance, that it is a practical impossibility to find all the cases. If two experts, men who have had much practical experience with this disease, cannot control it in a block of young, smooth-barked, thrifty Alexanders, by going over the orchard very carefully tree by tree seven times, how can the busy

orchardist hope to grow successfully this variety or any other equally susceptible, such as the Transcendant crab?

The disease made its appearance in Flathead county, near Columbia Falls, in the summer of 1909, but before it had made much headway the state horticultural inspector, with the local authorities, succeeded in completely exterminating it. None has appeared there since that time.

While this review of the blight conditions in Montana may seem to the inexperienced to indicate a special prevalence here, yet such is not the case. This State was one of the last to be reached by the disease, which is prevalent all over the United States, and one of our most important fruit growing sections is still free from it. Indeed, the resistant varieties may be expected to suffer as little here as anywhere in the country.

CAUSE AND SYMPTOMS OF THE BLIGHT.

The pear and apple blight is a disease that has spread over almost the whole of the United States, causing the total destruction of susceptible varieties in many orchards and their replacement by varieties more resistant. In many places fields of grain now wave where once stood orchards valued at thousands of dollars, or the land has been planted to peaches, plums, apricots, etc., which are not ordinarily attacked by this disease.

The disease is caused by a germ, microbe or bacterium,—a parasite quite unlike most others that attack orchard trees in Montana. It attacks the pear, apple, quince and a few other pomaceous fruits, but practically never the stone fruits—peaches, plums, cherries, etc. It gains entrance to the tree in several ways: through wounds made by pruning tools, cultivation, etc., or those made by the bites of insects; but most frequently it enters the open flowers, being carried about freely by bees, ants and other insects. When once the germ gains entrance it multiplies rapidly and works downward through the bark, but may not cause any visible effect until weeks after the infection has taken place, so that the grower is badly deceived as to just when the disease was acquired.

The symptoms are very characteristic. If the infection begins in a flower cluster or in the ends of a shoot, as is usually the case, the leaves first wilt and droop, then turn brown in the apple, and



Typical appearance of blighted limb of pear. The disease ran down from a blossom infection in the tip of the left-hand limb. One-fourth natural size.

nearly black in the pear. Soon they become dry, hard, and brittle. The bark of the affected twig likewise becomes slightly darkened in the apple and nearly black in the pear. The line between the diseased and the healthy bark is not sharp and distinct during the growing season, so that it is often difficult to determine just how far the disease has progressed, and it is usually farther than the inexperienced person would suppose. On cutting into the diseased bark one finds the inside at first pinkish in color instead of a healthy green, but when it has been diseased for a few weeks it becomes darkened through to the wood, which remains nearly white and normal. This is essentially a bark disease and will continue, in susceptible varieties, to run down the limbs and trunk into the roots, sometimes killing the tree outright in a single season. It practically ceases to spread downward at the end of the growing season and becomes dormant during the winter, but with the opening of spring, activity is renewed and another stretch of bark is killed. This continues until the tree is completely overcome. Sometimes the attack begins in the water sprouts at the base of the tree; under these circumstances it reaches the roots in a few weeks, where it cannot well be treated, and the case becomes practically hopeless.

Often there may be seen on the blighted leaves and branches, and especially on the blighted fruits, a yellow, gummy exudate in tiny droplets, or even in larger quantities, running down the tree. This contains enormous numbers of the germs of the disease, and is freely visited and eaten by ants, wasps, bees, and probably other insects that carry it to other trees, especially to the flowers, where a fresh attack begins. A single bee may thus infect several hundred flowers during the blossoming season, and a swarm of bees could infect many thousands. This accounts in most cases for the very extensive and sudden attacks that many orchards have suffered.

When the healthy leaves have fallen in the autumn, those on the diseased twigs and branches still cling to the tree, where they are very conspicuous. At this time also the diseased bark has turned quite dark, especially in the pear, and the line between it and the healthy bark is more sharp and distinct than during the summer season. Here, in the deeper layers of the bark, in the line between the diseased and the sound tissues, the bacteria that cause

the blight live over winter. On the assumption that they do not live over in the ground or anywhere else excepting the region just indicated, the following treatment is advocated by the U. S. Department of Agriculture and by many of the experiment stations, and is extensively practiced by orchardists with some measure of success.

TREATMENT OF THE BLIGHT.

In a single sentence we can say that the only known method of curing a blighted tree is to **cut out and burn all affected parts**. This seems simple enough, but there are important details that determine between success and failure. As a matter of fact **very few inexperienced men are successful**, largely because they will not pay close enough attention to these important details. The following rules should therefore be thoroughly mastered and religiously followed.

1. See that no blight is allowed to winter over in the trees. The best time of the year to cut it out is late fall or early winter.
2. In the dormant season the blighted branch should be cut off about a foot below any visible portion of the disease; in the summer two or three feet below. If this necessitates cutting off a larger limb this should be done. It is this rule that is transgressed most often and with the most serious consequences.
3. After each cut the saw or shears must be disinfected. The disinfectant can best be carried in a milk bottle attached to a belt, and can be applied with a swab. Small corrosive sublimate tablets (4 to a pint of water) make an excellent disinfectant. A 5 per cent solution of carbolic acid is also good.
4. Burn all diseased parts promptly after cutting. In summer **this must be done the same day**, otherwise insects crawling over them during the night may become carriers of the germs. In winter it is necessary to burn before the first warm days of spring, but many have neglected this rule to their sorrow.
5. Inspect every tree carefully after the orchard has been gone over. Even an expert, when cutting out blight, has to do this two or three times to get every case, and a case or two left may ruin the whole campaign by starting the blight in the blossoms the next season.

6. Pruning. Orchards in infested districts should be kept free from water sprouts at the foot of the trees, and from suckers and fruit spurs on the main limbs; otherwise the bacteria, entering through these tender parts, will quickly reach the roots or the trunk.

7. Tillage and Irrigation. Anything that favors a rapid succulent growth of the tree makes it more susceptible to blight. It is, therefore, most important that blighted orchards should have no more tillage and water during the first half of the growing season than are absolutely necessary to the making of the crop. Barnyard manure should be applied only to the more resistant varieties.

8. Kill the green apple aphids. Observation and experience



1. Twig infection, probably through punctures by the green apple aphids.
2. Tree doomed through water-sprout infection in the root.

have convinced us that the winged adult of this insect is the most important carrier of the blight after the bees stop working in the flowers. Thorough spraying with tobacco extract for the green aphids should greatly reduce the spread of blight during the summer.

The claim is sometimes made by those who have grown fruit in the East or Middle West previous to coming to Montana that the cutting out of blight is not necessary, that such a practice was very little followed where they came from and yet apples were grown with very little trouble from blight. The explanation is simple. In those sections the most susceptible varieties, as the Alexander and Transcendant crab, either have been little planted or have since been killed out. As the blight germs usually die out during the winter in other varieties, there is much less danger of an outbreak and the few cases that appear usually make only a twig blight. Doubtless we will have such a condition here after the susceptible varieties have disappeared, but meanwhile we must make a hard fight to save the industry. It should be remembered, however, that nearly every apple district, East and West, has a severe outbreak now and then that requires severe cutting.

THE SELECTION OF RESISTANT VARIETIES.

As already indicated, there is a great difference between varieties of apples and pears as to their susceptibility or resistance to this disease. Trees may be resistant in either of two respects or in both. First, if the blight germs get into the blossoms or the tender bark a natural resistance of the tree may prevent them from getting a start in many cases. Second, if the disease gets a start in the blossoms, the leaves, or the tender shoots, it will in some susceptible varieties spread down into the bark of the larger branches, trunks, or even roots; while in other varieties more resistant, it will die out early in the season, forming only a "twig blight." This kind of resistance is the more important.

Nothing is so essential in fighting this disease as to avoid planting susceptible varieties, which are almost certain to be killed if attacked, and to pull out or top-work those already growing. It would be impossible and quite useless to list here all known varieties of apples and pears and state the degree of susceptibility of each, for most of them have no commercial value in this State. The Mon

tana fruit growers may, however, find here listed most of those varieties that have a commercial value in one or more of our important sections, and they should be guided by it in the setting of new orchards.

*Class A. Relatively resistant, i. e., the blight seldom runs far in limbs more than one-half inch in diameter, and usually makes only a twig blight.

Duchess of Oldenburg	Wagener
Gano	Stayman Winesap
Ben Davis	Thompkins King
Rome Beauty	

Class B. Moderately resistant, i. e., the disease seldom runs far in limbs more than three-fourths inch in diameter, and usually makes only a twig blight.

McIntosh Red	Wealthy
Jonathan	Baldwin
Delaware Red	Northwest Greening
Grimes Golden	

Class C. Moderately susceptible, i. e., the disease frequently penetrates the smaller limbs (an inch or less in diameter) but seldom the main limbs or the trunks.

Yellow Transparent	Whitney crab
Fameuse (Snow)	Martha crab
Spitzenburg	Hyslop crab
Delicious.	

Class D. Very susceptible, i. e., many infections may appear in a tree; the blight extends rapidly into the larger limbs and trunks, and the tree is usually killed.

Alexander	McMahon
Wolf River	Winter Banana
Transcendant crab	

*Note: In the preparation of these lists I am indebted to several experienced pathologists for suggestions, especially to Mr. M. B. Waite, of the U. S. Department of Agriculture, and to Mr. M. L. Dean, State Inspector for the Montana Board of Horticulture.

In considering the above lists the grower should understand that classes A, B, and C rank quite close together, and that any of those varieties can probably be grown successfully even in blight-infested districts of the State; while between class C and class D there is a very wide difference, the latter being very much more susceptible. It is an exceedingly important fact that in trees belonging to classes A and B the blight germs nearly always die out in the bark before winter and almost never live over until the next spring, while in those belonging to class C they frequently live over winter, and in those of class D they quite regularly do so and thus start a new infection in the orchards at blossoming time. Our orchardists should not attempt longer to grow these five varieties. When the State was free from blight some of them proved very profitable, but now they are doomed to be replaced by others that are more resistant. It would be most unwise, therefore, for a grower to set them out.

As for the trees of susceptible varieties that have already been planted and have reached the age of bearing, they may be top-worked to varieties more resistant as soon as the blight has come close enough to warrant it. This applies especially to the Alexander, which is in most respects an excellent stock upon which to graft other varieties. Trees thus treated, **if kept free from water sprouts**, will make valuable orchards, and will thrive even in the midst of the blight, only occasional trees being lost. If, however, the water sprouts are allowed to grow, they furnish the blight with a quick and easy path to the root of the tree, and the orchard may thus be ruined.

RELATIVE RESISTANCE OF THE PEAR.

Pears have been grown only to a limited extent in Montana, but those trees that have come into bearing have proved so profitable that something should be said for the guidance of those who are debating planting them more extensively.

It is a misconception that pear trees growing in any locality are a special menace to the apple industry. Pears are no more likely to contract blight than apples; and if they have it and the owner desires to fight it he will find it not so difficult to combat in the pear as in the susceptible apples.

The reason for this is that the normal bark of the pear is lighter in color and the blighted portions darker than in the apple; it is therefore easier to find all the blighted limbs. In general we may say that it is much easier to control the blight in pears than in the apples listed in class D.

Pears, like apples, differ in their susceptibility to this disease. The Clapp's Favorite, for example, blights so badly that it cannot be grown commercially with profit. The Kieffer, on the other hand, is about as resistant as the apples in class B. Unfortunately it is not a first class variety for eating, though it is prized by the canneries. There are three other varieties that have commercial possibilities in this State,—the Bartlett, Buerre d'Anjou, and Flemish Beauty. Of these the Bartlett is the most susceptible, though hundreds of thousands of trees are being grown where blight has existed for years. Buerre d'Anjou is decidedly the most resistant, being raised very profitably in Colorado for example, where the blight has greatly injured most other varieties. Both of these are decidedly superior in quality of fruit to the Flemish Beauty.

All pear orchards grown where blight is found will develop some cases in the tops—many of them if the orchards are neglected. These may, however, be controlled by the methods outlined in this circular. The principal loss of trees is caused by the blight's running down the limbs into the trunks, or, worse yet, by its reaching the roots through the water sprouts. To avoid this loss it is important that a pear tree shall have a body and roots of a variety resistant to blight and not likely to sprout. Use for a stock the Chinese sand pear, often called "Japanese" stock, which is much more resistant than the French seedling and does not sucker so badly. Upon this graft the Kieffer or some equally resistant cion. Set deep in the ground so that roots will be sent out above the union. In pruning, leave four main limbs, and the second or third year after grafting, top-work these limbs to the desired variety,—for example, Buerre d'Anjou. The buds or grafts should be set one to two feet from the trunk. This will make a fine, large tree, and should the blight run down a limb to the point of union it will there be checked, and a new limb can be grown in place of the one lost. For convenience one can order from the nursery Kieffer stock on "Japanese" roots and do the top-working himself at the proper time. This system has been thoroughly tried and we

recommend it unqualifiedly to those who wish to grow this much-prized fruit.

Lastly, it seems important to explain here to the citizens of Montana the relation of the State Experiment Station to the control of this and all other plant diseases. Two organizations are working to this end, the Experiment Station and the State Board of Horticulture. It is the duty of the Station to investigate new plant diseases, and to work out new remedies and improve the older ones for any and all diseases, whether new or old; to examine and identify diseased material, and to disseminate in every possible way knowledge and advice concerning these diseases. It is not, however, its duty, or even its privilege, to employ men to do the work of treating or eradicating diseases, excepting experimentally, or to enforce the State laws concerning these diseases, and to do so would be to misappropriate the funds allowed for this work. The enforcement of the horticultural laws and the destruction of diseased materials, etc., are among the special duties of the State Board of Horticulture.

In the attempt to eradicate the blight from the infested sections of Montana, and to keep it from spreading into districts as yet free from it, the Experiment Station has done in the past, and stands always ready to do, all that the laws and funds will permit.